Weatherwise

The Ice Storm - A Winter Menace

Ice Damage to Trees

Weather Wisdom and the Telephone

Frostproof and Frostburg

The Famous Storm of November, 1913

Vol. 2, No. 6, December, 1949

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE" — BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

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AMS National Meeting

ON BEHALF of the American Meteorological Society, I am pleased to extend a cordial invitation to all members of the Amateur Weathermen of America to attend our 104th national meeting in St. Louis, Missouri, January 3 to 6, 1950, and to participate in the activities.

This, our 30th anniversary meeting, will be the most outstanding meeting in our history. An unusually large attendance is anticipated because of the close co-operation of the Air Force and Navy in arranging concurrent meetings of reserve weather officers and aerologists, and because of the interest shown far in advance by industry, government agencies, and educational institutions.

A feature of the meeting will be a symposium on air pollution, in two main parts, and under the chairmanship of C. A. Gosline, meteorological engineer at the du Pont Company. On the evening of January 3rd he will act as moderator of a panel by leading national authorities on the different phases of air pollution abatement, such as enforcement, public health, equipment, industrial research, and the like. This discussion will be open to scientists, technicians, and the public alike and, following a brief description of each panel member's special subject, comments and questions from the floor will be invited.

The second phase of the symposium will be a series of technical papers presented on January 4th. These have been selected to emphasize the meteorological and climatological phases of air pollution, covering such subjects as the urban diffusion of smokes, forecasting atmospheric dispersion conditions, dispersion from stacks, climate influences on pollution, the problems of turbulent diffusion, and meteorological instruments useful in studies of air pollution.

Those who will be able to attend the AMS 104th national meeting, and I sincerely hope there will be many, should make room reservations in advance. The headquarters for the meeting is the Hotel Jefferson. We shall look forward to seeing you in St. Louis.

HOWARD T. ORVILLE, *president*
American Meteorological Society

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Cover: Ice storm damage at Bolivar, Missouri, January 10, 1949, photographed by Betty Love, and reproduced by courtesy of C. C. Williford, USWB, Springfield, Missouri. Mr. Williford states that at Springfield very little damage was done, but at Bolivar, 20 miles to the north, the storm was the worst he had ever witnessed. From Bolivar to the north and northwest for 150 or more miles the damage was equally as great. See the chart on page 124 for the general conditions that day. Springfield Newspapers, Inc., photograph.

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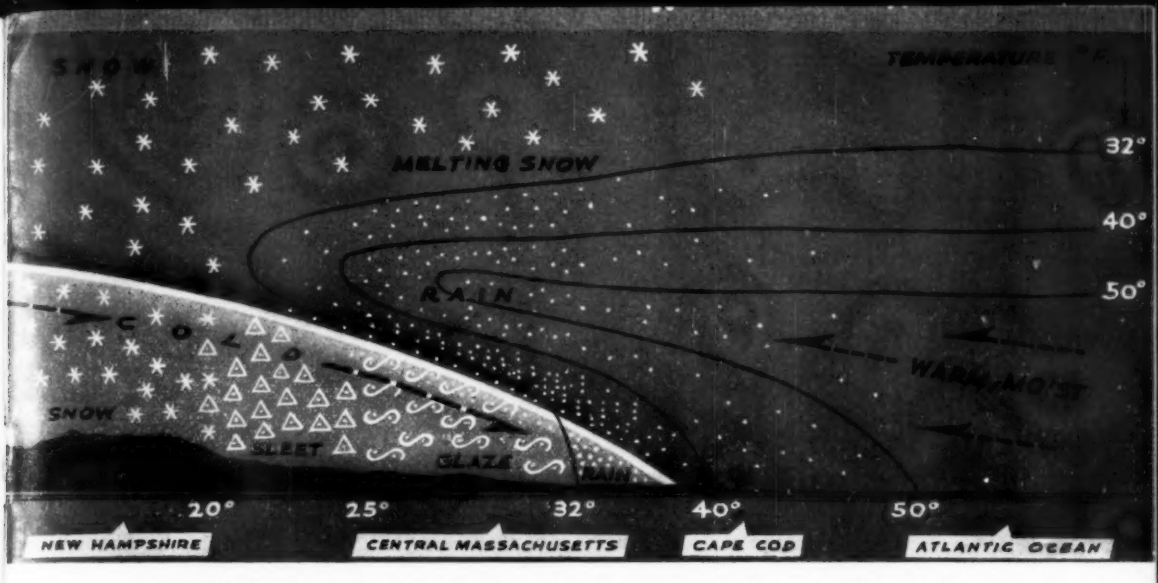


An idealized cross section of the atmosphere from Cape Cod, Massachusetts, northward to New Hampshire during the famous ice storm of 1921. Successive areas of rain, glaze, sleet, and snow are produced by the vertical distribution of air masses. Drawing by Eric Sloane.

The Ice Storm — A WINTER MENACE

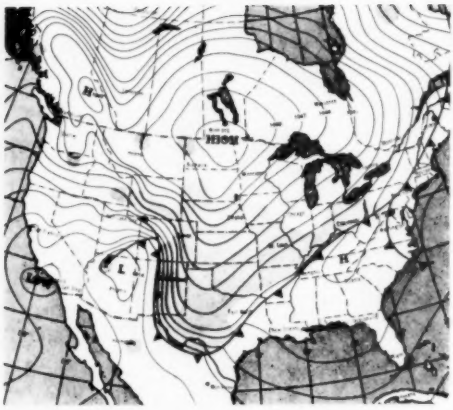
LILLIAN KIVIAT, HYDROMETEOROLOGICAL SECTION
UNITED STATES WEATHER BUREAU

ICE-COATED WIRES, looping between poles, glittering in the sun, look like diamond necklaces. The resemblance goes even further than the dazzling beauty, however. Both are expensive! The ice storm in its winter visitations takes a toll in telephone and telegraph poles, power lines, trees, and buildings, that runs to fabulous sums.

During the past winter, on January 10, 1949, the region of the Ozark Mountains experienced one of its worst ice storms. A large area in adjoining portions of Missouri, Arkansas, Oklahoma, and Kansas, received a thick icy sheath. Glaze-covered highways disrupted land traffic, while air travel was grounded by ice accumulation on wing and propeller surfaces. Telephone, telegraph, and power lines sagged under the two- to three-inch burden of ice; many poles snapped, bringing down a hopeless mesh of wires, to cut off communication. Limbs were torn from trees, and whole trees were felled under the crushing weight of ice, adding to the chaotic scene.

The cities of Joplin, Carthage, and Bolivar, all in Missouri, were particularly hard hit. This storm again emphasizes the susceptibility of modern city life to complete paralysis from the effects of glaze. In Bolivar, fully 90 per cent of both power and telephone poles were shattered (front cover). When electric power lines go out, many homes are rendered uninhabitable as electric furnaces, stoves, hot water heaters, and laundries cease operation. Springfield, Missouri, was almost isolated at the height of the storm with highways blocked and power cut off.

The mainspring of these beautiful, yet vicious, manifestations of nature is an unusual vertical distribution of temperature. The air at the ground and objects on the ground must be at 32° or below, while the air aloft is well above the freezing point. Overrunning of a cold air mass at the surface by a warm air mass aloft can occur during the winter months in many parts of the country, as shown by the map on page 124. But it is also necessary to have the warm air aloft with high moisture content and at or near the condensation point. Precipitation falls from the warm air as rain; the water droplets become supercooled but do not freeze in the wedge of cold air; instantly upon striking a cold surface the droplets



The surface map for 1:30 p.m. EST, January 10, 1949. The shaded areas show regions of precipitation, in many of which severe ice storms occurred.

solidify into a smooth glaze of ice on all exposed objects. If the layer of cold air near the ground is a thick one, the resultant precipitation may be sleet, a form of frozen precipitation resembling ice pellets, which is already solid when it reaches the ground.

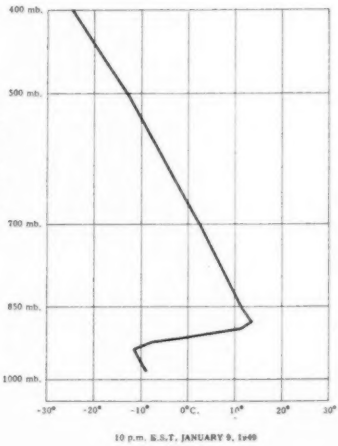
The daily weather map for 1:30 p.m. EST, January 10, 1949, is a good example of the ice storm type. A cold front had just pushed down into Texas and extended northeastward to the Great Lakes. The following high pressure area was of great magnitude, with surface temperatures in the Middle West running 10 and 20 degrees below freezing. Ahead of the cold front, however, an energetic stream of warm, moist air from the tropical Gulf advanced. As the warm air reached the wedge of cold air, it was forced up over the denser body, its moisture was released, and the freezing rainstorm spread over the Ozarks region.

The temperature sounding taken aloft over Oklahoma City the previous evening is illustrative of the temperature inversion existing in the vicinity of a winter front. From the surface to 1,000 feet, the air was about 16° C. below freezing; then suddenly there was a sharp rise of 25° C. in the next 1,000 feet. The bulk of the air above Oklahoma City was warm, but that shallow layer of freezing air made the difference between an ice storm and merely a heavy rainstorm.

Forecasting an ice storm is a delicate task with many factors involved. An accurate forecast of surface temperatures below the freezing mark must be made 24 hours in advance. The type of synoptic pattern which would supply a steady flow of warm, moist air over cold air must be assured. It is as important to determine whether the warm air will be lifted to the level where it will be cooled sufficiently to release its moisture as rain. The wind is another element of importance because strong winds and gales have a tendency to alter the temperature stratification and to form sleet instead. Most ice storms have winds between gentle and fresh.

The area of greatest frequency of ice storm occurrence is a great crescent-shaped arc extending from central Texas northeastward to Missouri and Illinois, then eastward across the Ohio valley and the lower lakes to New England and the Middle Atlantic states. Here is the region of maximum clash of cold and warm air masses and where the critical near-freezing temperatures frequently occur in wintertime. Mountain regions, too, are susceptible to glaze as some portion of a mountain slope is usually in the freezing area. The Appalachians in the Southeast and the Cascades in the Northwest, both near adequate moisture sources, often experience severe icing conditions.

The month of November, 1921, was strangely marked by two very severe ice storms at extreme ends of the country. From November 19th through 21st the Columbia River area in the Northwest was locked in the grip of a combined rain, ice, sleet, and



The sounding of the air above Oklahoma City at 10 p.m. EST, January 9, 1949.

snow storm of exceptional character. Adjacent parts of Washington, Oregon, and Idaho were affected. The ice phase of the storm occurred principally in the vicinity of the Columbia River Gorge and the city of Portland. A high pressure area built up over the Continental Divide region of Montana and forced an efflux of cold, continental, polar air through the mountain passes and into coastal sectors. Another high pressure center, poised near the coast, brought an inflow of moist, maritime air from the Pacific Ocean. The maritime air glided up over the cold, polar air that occupied the coastal area and inland valleys, causing rain on the coast, ice glaze farther inland at the base of the mountains, and sleet and snow at higher elevations and on the inland plateau.

The city of Portland was near the center of the severe icing area. The lowest temperature at the city Weather Bureau office during the storm was only 29° on the 20th, and by that evening it had edged up above the freezing mark. Although ice in the business district soon melted, the eastern part of the city remained in the polar air and was not freed from the icy grip for two days.

The precipitation from this storm was particularly heavy, as the moisture-laden air from the Pacific continued to flow over the cold wedge of polar air. As much as 13 inches were registered over the three-day period just to the east of Portland in the foothills of the Cascades. At lower levels a mixture of snow, sleet, and glaze fell, reaching an extreme accumulation of 54 inches at The Dalles (elevation 96 feet), blocking all highway and railroad traffic through this key communication point. Farther inland, record November snowfalls were reported in eastern Oregon and Idaho.

Another unusually severe storm occurred a week later in the opposite end of the country, with the ice phase centering in central Massachusetts. This storm, though smaller in area than the Columbia River one, struck a much more highly industrial area. A low pressure center off the southern New England coast produced the requisite inflow of warm air, while a high pressure area over Quebec supplied the necessary wedge of cold air. In Cape Cod and Rhode Island heavy rain fell; farther north in the Boston-Worcester territory it turned into a freezing rain. Boston had three inches of precipitation with surface temperatures down to 26°. In New Hampshire and Maine the fall was either all snow or a mixture of snow and sleet.

A chicken house was ruined when ice caused this tree to fall during the storm at Bolivar, Missouri, in January, 1949. Photograph by Betty Love, courtesy C. C. Williford.

The icy covering extended inland from the coast about 60 miles. Along the main line of a single railroad 2,700 telegraph poles were down. The weight of the ice on the wires between poles was estimated to be two tons. Losses to telephone and power companies amounted to $5,000,000. The damage to trees ran between five and ten millions. From 7,500 to 8,000 trees were destroyed and had to be cut away, while another 5,000 to 7,000 were so badly mutilated that replacement was necessary within five years.

As in the case of other natural catastrophes, the only protection against ice storms lies in a few precautionary measures and in timely forewarning. Power and communications companies have spent much time and money in designing poles and wires that will stand the extra burden of ice, and lines have been kept clear of protruding trees and branches. But most important are timely mobilization plans so men and equipment can be called upon to repair the damage of ice soon after the storm ceases. Here again is a field where the forecaster is of inestimable value to the industrial world in maintaining the operation of public services.

The Famous Storm of November, 1913

C. P. MOOK, UNITED STATES WEATHER BUREAU

ON SUNDAY MORNING, November 9, 1913, the Great Lakes steamer, *Howard M. Hanna Jr.*, sailed from Port Huron, Michigan, into Lake Huron. The wind was from the northwest, which placed the ship in the lee of the protecting shore. An unusually low barometer was noticed, but there was no suspicion of the violence of the storm which was soon to envelop the *Hanna*. It is doubtful if any storm before or since has produced the seething mass of water, snow, and wind on Lake Huron which those who manned the ship experienced that day.

The *Iron Trade Review* for November 20, 1913, relates how the water suddenly broke over the *Hanna* with incredible force and carried away the after cabin. Attempts to keep the ship headed to sea were in vain. Hatches were torn off, the engine room was flooded, and finally the *Hanna* was broken in two on a reef. Of the two lifeboats, one was carried away by the storm and only six men reached shore in the other.

All remaining men of the *Hanna* were rescued later, but on other ships 200 lives were lost in Lake Huron during this storm. Ships such as the *Charles S. Price* were not as fortunate as the *Hanna*. The *Price* was found floating seven miles offshore completely turned over. Watches found on dead bodies washed up from the various foundered ships were generally stopped between 8 and 11:30 p.m., probably indicating the time when the boats went to pieces.

The disasters which occurred on the lake were but a part of the widespread effect of this memorable storm of November, 1913. At Cleveland, Ohio, it produced the greatest snowstorm on record, which, combined with the freezing temperature and wind, caused suffering and damage to an extent that almost completely paralyzed the city. In addition, the winds sweeping southward from the lakes brought record snowstorms to the western portions of Pennsylvania, Maryland, and West Virginia, reaching depths of one to three feet. Strangely enough, little or no precipitation fell east of the Appalachians during the storm.

Mariners on the Great Lakes know from

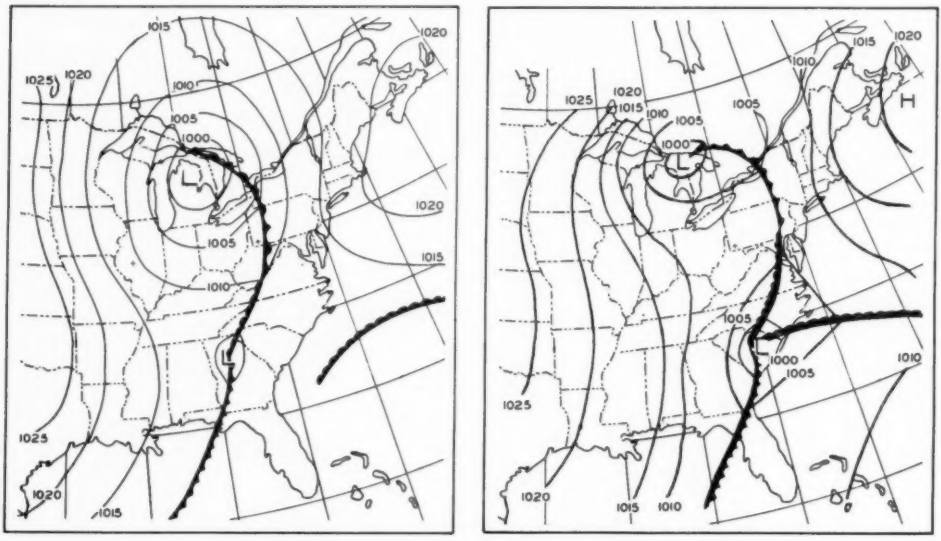


Fig. 1. Synoptic charts for November 8, 1913, for 8 a.m. EST (a, left) and for 8 p.m. (b, right).

experience the effect produced by a wind which has had a long journey over water, as compared with a wind from a nearby shore. For the same wind speeds, the larger and more turbulent seas are produced by the longer water trajectories. Not only is the frictional drag on the wind less over water than over land, but the effect of the wind on the water is such that the heavy seas grow in advance of the wind. The disaster on Lake Huron was associated with a fierce wind from the north-northeast, which began its push over the water in the northern portion of the lake and traveled nearly its entire length to engulf the ships in the southern half.

With a low pressure disturbance over the lakes such as that shown on the morning weather map of November 8, 1913 (Fig. 1a), the winds would normally be expected to be from the northwest as the low pressure center moved eastward. Why then did they shift to the dangerous northeast quadrant so suddenly and then persist for so long?

For part of the answer let us examine the evening weather map for the same day, Saturday, November 8th (Fig. 1b). Note the weakening of the storm on the lakes and the development of a new low pressure disturb-

The steamer *Charles S. Price* is shown in the top part of this composite photograph as she appeared on a voyage before the fateful storm of November, 1913. The lower portion of the picture shows the vessel capsized in Lake Huron a few days after the storm. She eventually sank. Young photo from *Lore of the Lakes.*

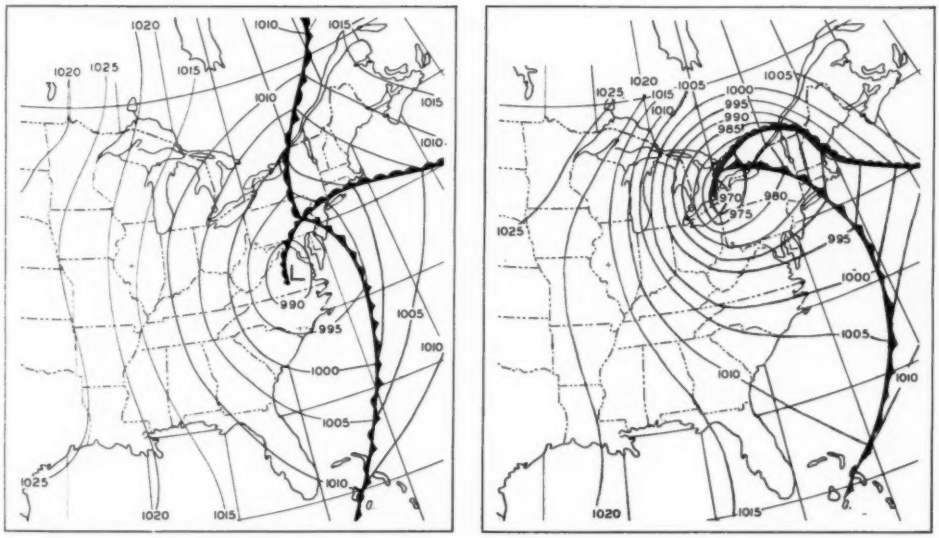


Fig. 2. Synoptic charts for November 9, 1913, for 8 a.m. EST (a, left) and for 8 p.m. (b, right).

ance in the Carolinas. By Sunday morning, November 9th (Fig. 2a), the secondary storm was intensifying rapidly and moving northward through Virginia, and by evening it had passed over Erie, Pennsylvania, with its central pressure down to 28.61 inches or less than 970 millibars.

The weather map for the evening of November 9th (Fig. 2b) also shows what was happening over Lake Huron. Note here that isobars are closely spaced and are oriented from the northeast, and that a gradient wind from the northeast had been slowly increasing in intensity in this region since the preceding evening. Thus we see the rare combination of circumstances which cost the lives of so many men in so short a time on Lake Huron.

Meanwhile the people of northern Ohio, and of the western portions of Pennsylvania, Maryland, and West Virginia were experiencing a heavy snowstorm accompanied by strong winds and gales. Traffic of all kinds was brought to a near standstill as the storm raged, and remained so until the roadways could be cleared of drifted snow.

At Cleveland, Ohio, the storm began in the early hours of November 9th with the temperature near 36°. Precipitation, beginning as rain during the night, changed to snow before noon, as the temperature fell, and by nightfall all exposed power and communication lines as well as trees were covered with a thick coating of ice and snow. W. H. Alexander, writing in the *Monthly Weather Review* for November, 1913, relates how, under the pressure of a 50-mile gale, poles and wires began to break and fall in every direction so that telephone, telegraph, trolley, and electric light services were completely paralyzed or seriously crippled. Between 7 p.m. of the 9th and 7 p.m. of the 10th, 17.4 inches of snow fell, breaking all previous records for 24-hour snowfall. By 2 p.m. of the 11th, when the snow finally ended, a total of 22.2 inches had fallen.

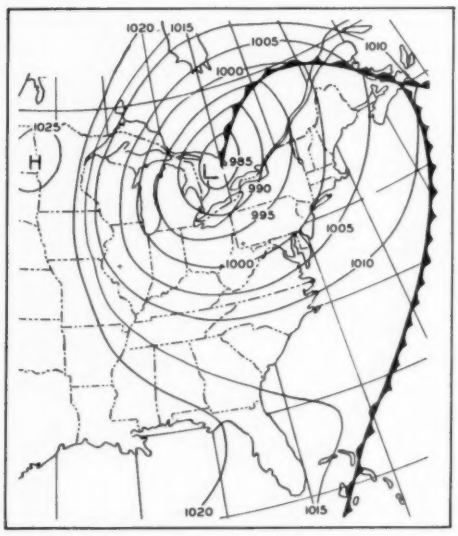


Fig. 3. The synoptic chart for 8 a.m. EST, November 10, 1913.

In western Pennsylvania the snowfall was generally heaviest from Pittsburgh southward, although according to the report of G. S. Bliss, which appeared in the same November issue of the *Monthly Weather Review*, damage to power and communication lines appeared heaviest in the Beaver Valley. Trains were delayed as much as 24 hours, and passengers were reported to have visited nearby farmhouses for provisions. At Pickens, West Virginia, the Weather Bureau cooperative observer, Dr. J. L. Cunningham, measured a depth of three feet of snow. Parkersburg, where all snow which fell in November during the previous 25 years had totaled but 23.8 inches, reported 15.9 inches for this storm.

At Buffalo, New York, the gale reached a maximum speed of 80 miles per hour during the afternoon of the 10th and was accompanied for a while by a driving snowstorm. Being east of the storm track so that winds were offshore, Buffalo did not accumulate snow to the great depths reported elsewhere. In all of Lake Erie only one vessel, a lightship, was sunk during the storm. Losses were also reported from other of the Great Lakes, but nowhere comparable with the toll of ships and lives on Lake Huron.

The morning weather maps reproduced herein contain the fronts which are to be found in the analysis of these maps as published in the Northern Hemisphere Sea Level Synoptic Series. The evening maps show the fronts as interpolated using the original manuscript sea-level weather maps of the Weather Bureau as filed in the National Archives in Washington, D. C.

WHEN WINTER BEGINS

S. S. VISHER
PROFESSOR OF GEOGRAPHY
INDIANA UNIVERSITY

WINTER COMMENCES at different dates in different parts of the country, instead of everywhere on December 1st, as those who abide by the conventional calendar divisions of the year maintain, or at the winter solstice (December 22nd), as declare those who go by astronomical dates.

The coldest quarter of the year normally begins, as Fig. 1 shows, nearly a week before December 1st in much of the West. It commences about a week after December 1st in much of the Northeast. For a wide belt extending from North Carolina to Idaho, and

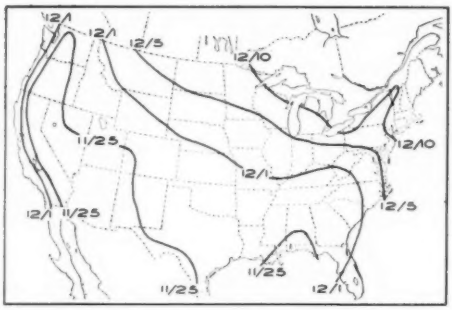


Fig. 1. The dates on which the coldest quarter-year usually commences (after Kincer).

also close to the Pacific Coast, it commences on or close to the 1st of December. Hence, for a large part of the nation's population, it

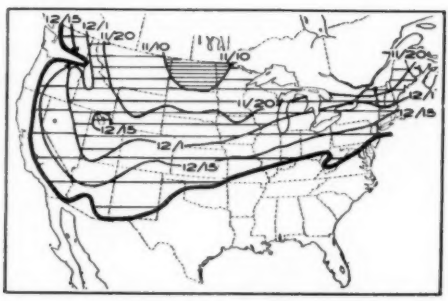


Fig. 2. The dates when the daily temperature normals fall below 32°.

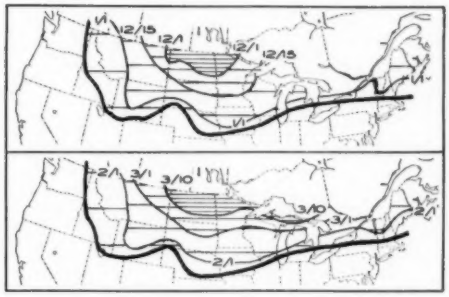


Fig. 3. The dates when the daily normals fall below 20° (top), and rise above 20° (bottom).

starts approximately with the calendar. (This map is adapted from one by Kincer in *Weekly Weather and Crop Bulletin*, September 29, 1942.)

Winter is often considered as beginning, in the colder part of the country, when the daily temperature normals fall below freezing. Fig. 2 shows that on this basis winter commences in the last 10 days of November in an extended northern area, but it starts in the first 10 days of November in North Dakota and northwestern Minnesota. Winter does not commence on this basis until about December 15th in a zone which extends from Boston to Arizona. Much of the

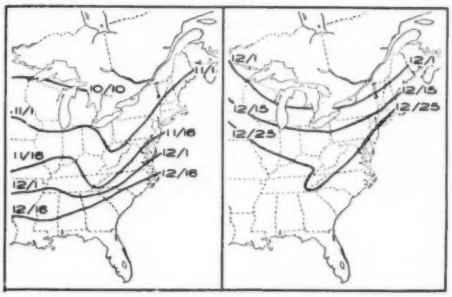


Fig. 4. The dates of the first measurable snowfall normally (left), and of the first three-inch snowfall (right).

South and a Pacific coastal zone do not have daily normals below 32°, and hence on this basis lack winter.

Where daily normals fall below 20° (Fig. 3), such cold weather normally commences shortly before December 1st in the coldest part of the country, centering in the Red River Valley of the North, but not until

about January 1st in the belt that extends from parts of New England to Wyoming. "Cold winter" ends about February 1st in that belt, but not until March in a belt from Lake Huron to Montana, as shown in Fig. 3.

The coming of snow is often thought of as indicating the beginning of winter, so that Fig. 4 has some propriety here. The first snow comes in October in the North, but not until December near the southern margin of the snow belt. A large portion of the people of the United States receive their first considerable snowfall in November, because that belt contains more than half of the nation's population. As much as three inches of snow normally does not fall until approximately mid-December in that belt.

These six maps reveal significant regional contrasts, by no means exclusively latitudinal, in the dates when various aspects of winter arrive. They make clear that arbitrary dates, such as December 1st and December 22nd, are only locally correct.

The maps, except Fig. 1, are original. All are based on abundant official data. They have appeared in earlier more technical articles by the present writer, and are also parts of his *Climatic Atlas of the United States*. This is the fourth article on the seasons appearing in WEATHERWISE this year (April — spring, June — summer, August — end of summer, or beginning of autumn).

FROSTPROOF AND FROSTBURG

— How Did They Get Their Names? —

HOW DID they get their names, Frostproof, Florida, and Frostburg, Maryland? **Weatherwise** has inquired and received the following evidence:

Warren O. Johnson, meteorologist in charge at the USWB office in Lakeland, Florida, writes (via the Jacksonville USWB office) that he had trouble in finding any authentic reason for the town having the name Frostproof, but he quotes from Hetherington's **History of Polk County**, 1928.

"The name Frostproof was originally applied to the Lake Clinch section, formerly known as Fort Clinch. The name is said to have been given by the cowboys who herded their cattle in this highland lake region during the winter months and who would note the absence of frost there, even in the coldest spell. This was particularly noticeable during the severe cold that prevailed over Florida in 1894-95, when damage to Frostproof was very light and the fortunate growers who lived there shipped fruit the following year for which they received very high prices."

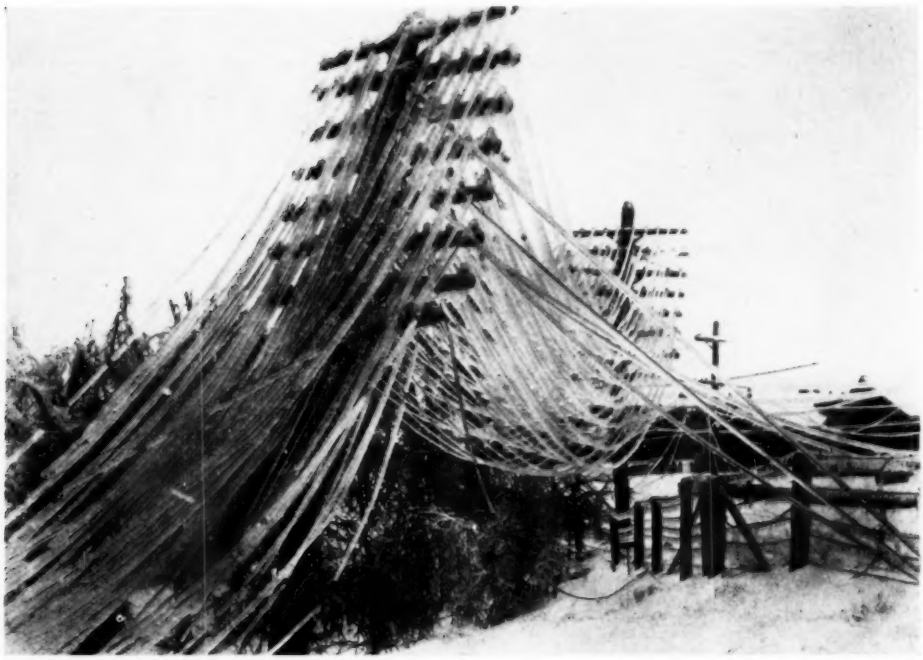
Mr. Johnson goes on to say that Frostproof is located on very high ground and, as a rule, is quite warm in comparison to the surrounding area. "We have some very cold stations in the vicinity of Frostproof that are as cold as any in central Florida. In view of this condition, during major freezes the high ground on which Frostproof is located would escape major damage, while in the immediate vicinity severe damage would occur. I do not believe that Frostproof is any freer from frost than some of our other towns located on high ground in the ridge area of central Florida."

At the request of the section director of the USWB at Baltimore, we hear from Charles A. Suter, Jr., co-operative observer at Frostburg, Maryland, along these lines:

"Frostburg is not named for 'Jack' Frost, but for a certain Meshach Frost, who with his wife Catherine settled in this community in 1812. Mr. Frost kept a tavern which was a favorite stopping place for congressmen on their way from the West and Southwest to Washington. Many distinguished men stayed overnight at his place, known in after years as Highland Hall. Among them were Henry Clay, Colonel Richard M. Johnson, and General Stonewall Jackson. The Frosts were not only the founders of the town, but the most prominent people in it, and one of the best known families along the National Highway.

"Frostburg is located upon a magnificent plateau between the Big Savage and Dan's mountains, 2,150 feet above sea level, and has a healthful, invigorating climate. The average growing season here is 161 days, which compares with that of 163 days at Cumberland, 623 feet above sea level, 11 miles to the east of Frostburg. The annual mean temperature here is 51.1°, and that at Cumberland is 52.8°. The average date of the last killing frost is April 30th, and it is May 1st in Cumberland. So you see we are not so frosty in Frostburg.

"Our annual average snowfall is 48.0 inches, while in Cumberland it is 30.0 inches. However, to the west of us at Grantsville, the snow averages in a year 68.9 inches. The lowest temperature ever observed officially here was −22°; at Cumberland it was −12°. Rainfall is well distributed throughout the year. Our wettest month on the average is June, with 4.82 inches, and our dry month is November, with 2.38 inches. We have an annual rainfall average of 41.56 inches, and Cumberland has 35.29 inches."



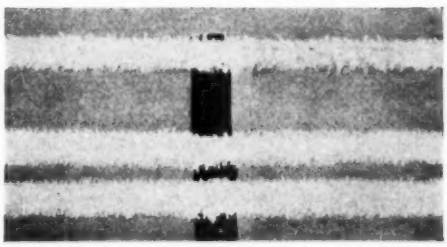
Ice-laden telephone wires at Summit, just east of Worcester, Mass. The ice weighed 800 pounds per wire between poles and was three inches in diameter. Photograph by New England Telephone and Telegraph Company.

WEATHER WISDOM AND THE TELEPHONE

J. A. CARR, BELL TELEPHONE LABORATORIES

TO THE TELEPHONE ENGINEER, the often-voiced question, "What's the weather?" has a special significance. Telephone lines, both open wire and cable, must be designed to withstand the elements even under severe conditions, and knowledge of the nation's weather is an important part of the engineer's stock in trade. An aerial line suitable for a heavy glaze section such as New England must be stronger than a line to be used in Alabama, and since it costs about one third more the economic urge to provide the proper design for varying weather requirements is great.

The severity of ice and wind storms cannot be predicted in specific cases. Design is therefore based upon the average severe storm conditions which might be expected from the history of the area. To design overhead lines for exceptionally severe conditions, such as hurricanes and tornadoes, would bring the cost of telephone service to such a high figure that few could afford it. The front cover and the picture above show the effect of unusually heavy ice storms. The lines shown are of the open wire type. Similar damage can be done to cable, but



The diameter of the ice and frost on these wires is seven inches. Bell Telephone photo.

In the absence of winter conditions at Bell Telephone's field laboratory at Chester, New Jersey, bricks substitute for ice to test the strength of wires.

not so frequently, since cable, because of the high-strength steel strand which supports it between poles, is better able to withstand wind, ice, and falling tree limbs. Cable lines have in some cases been known to hold up sizable trees that have started to fall.

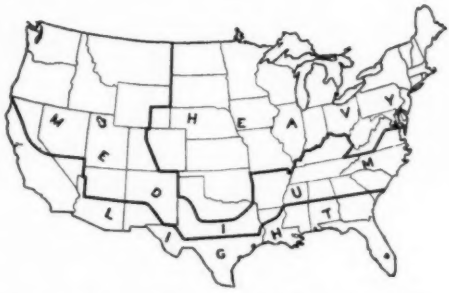
Telephone lines must withstand not only steady loads such as ice, but impact loads like those caused by falling trees and debris. At Bell Telephone Laboratories, research and development organization of the Bell System, studies are made of lines under steady and impact loads. A typical example of a steady-load test is shown in the picture where bricks are being used to simulate ice.

As the area of a circle is in proportion to the square of the radius, the weight of ice accumulation on wires increases rapidly with the thickness of the coating. A sheath of ice one quarter of an inch thick adds a load of only two ounces per foot of wire, whereas a one-half-inch coating adds six ounces per foot. A one-inch radial accumulation amounts to about 22 ounces for each foot, and in a 150-foot span this becomes about 200 pounds, or about 15 to 40 times the weight of the wire itself.

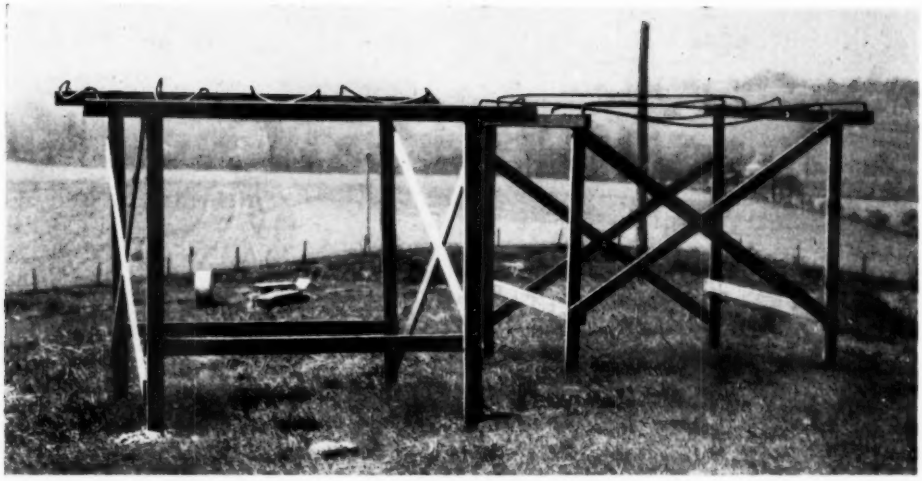
It is not only the weight of the ice on the wire, however, which makes damage possible. The "sail area" that the wire presents to the wind is increased. The diameters of line wires commonly used in telephone work vary from about .080 inch to about .165 inch, and it is readily evident that a one-half-inch radial ice coating increases the area exposed to the wind by seven to 13 times. With a strong wind transverse to the line, the wind pressure per foot of ice-covered wire may considerably exceed the weight of wire and ice combined. For this reason ice load acting together with wind forms a particularly destructive combination.

Winds need not have a very high speed to cause damage to the telephone plant. Some which are steady and moderate under certain conditions will set up damaging vibrations in wires and cables. When wind blows across a suspended cylindrical material such as line wire, eddies are formed alternately near the top and bottom on the lee side of the wire. These eddies impart little kicks to the wire and force it to vibrate. The frequency of such vibrations is directly proportional to the diameter of the conductor and inversely proportional to the speed of the wind. The vibrations cause the humming sound often heard in the vicinity of open wire lines. If the wires are not properly held at the supports, the vibrations may cause the wires to fatigue and eventually to break.

"Galloping" or "dancing" are terms given to another form of wind-induced vibration. In this type the wire or cable vibrates only a few times each second, but with high amplitude as compared to the rapid, low-ampli-



The National Electrical Safety Code storm loading areas of the United States.

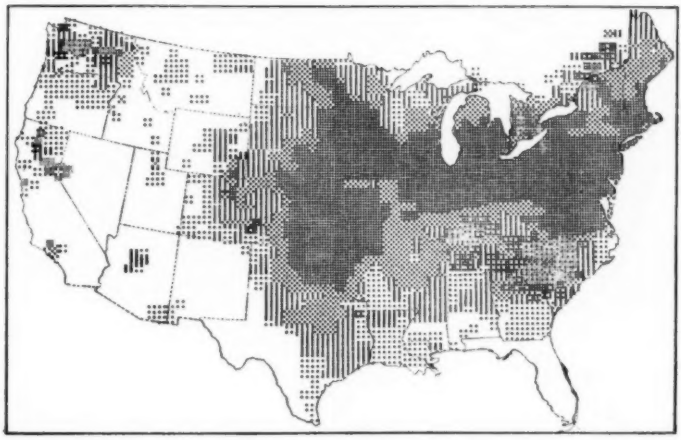


Ice catchers. These racks hold various sizes of wire and are located at about 250 places throughout the country in connection with ice accumulation studies. These studies are being conducted co-operatively by telephone, telegraph, electric power, and railroad companies. American Telephone and Telegraph Company photograph.

tude vibrations just described. These low-frequency vibrations appear to occur where the lines are open to prevailing winds of moderate speed, and particularly when some ice is present on the wire or cable. The dancing is sometimes of sufficient violence to short-circuit the wires; to cause mechanical damage at the insulators, due to chafing; or to produce breaking or weakening of the wire from the fatigue of the metal which results when the wires are bent back and forth while dancing. Some types of long-distance carrier telephone circuits must be built with relatively close spacing between the two wires constituting each pair, and on such circuits the swinging of ice-glazed wires in the wind may result in actual freezing together of the wires.

Since no sure means of eliminating galloping has yet been found, the best that can be done is to try to avoid the conditions that favor it. As part of its study of national weather conditions, the Bell Telephone System has collected data on the frequency and intensity of wind and ice storms from virtual-

(Continued on page 138)



The average occurrence of heavy ice storms during a 25-year period, as reported in the Bell Telephone System. The heaviest dots represent a storm at least once in three years.

A tree split by an ice storm. Photograph by Davey Tree Expert Company.

Ice Damage to Trees

E. P. METCALFE, MIDWEST SUPERVISOR, DAVEY TREE EXPERT COMPANY

DAMAGE TO TREES by ice storms has been investigated in recent years by commercial firms in the tree care business as well as by educational institutions in forest research projects. A good deal of variance in the reports occurs, partly because the studies were made under dissimilar terrain and topographic conditions and partly because of greatly differing meteorological conditions during and immediately after the storms.

The general conclusions, however, are reasonably uniform and may be summarized:

1. Heavy injury to finely branched species suggests that the amount of surface presented by the branches for ice formation is a considerable factor.

2. Old trees tend to be damaged more than sound young trees.

3. The degree of storm exposure is important.

4. The strength of the wood or its degree of weakness and brittleness is a factor, but not always of as great importance as might be supposed.

5. The longer the branches, the greater the leverage which the ice can bring to bear. Small trees are ordinarily less damaged than larger ones of the same species.

6. Accumulations of ice on horizontal branches (as with spruce trees) soon changes from a bending load to a pulling load that is carried well so long as the weight is symmetrically distributed.

7. Trees with flexible branches may bend into arches, but they seldom break.

8. Dense, low-branched evergreens may develop icicles downward from branch to

Courtesy of Davey Tree Expert Company.

branch and finally to the ground in such a way that all are safely supported by an ice structure. Branches of hawthorns and other small trees may bend to the ground and be similarly supported.

9. Trees with the always weak V-shaped forks will split down badly at these forks unless cabled or braced in advance.

Trees may be classified into three divisions in regard to their resistance to ice damage. Among those that survive best are:

Ailanthus (tree of heaven), yellow birch, American hornbeam, shagbark hickory, northern catalpa, hawthorn, common horse chestnut, beech (American and European), white ash, ginkgo, Kentucky coffee tree, butternut, American hophornbeam, Norway spruce, common chokeberry, oak (white, swamp white, eastern red, scarlet, bur), and eastern arborvitae.

Among those that have fair resistance to ice storms are:

Maple (Norway, plane tree, red, sugar), birch (European white, sweet, yellow, gray), common hackberry, katsura tree, American yellowwood, flowering dogwood, common persimmon, black ash, common honey locust, mountain silverbell, eastern red cedar, American sweet gum, tulip tree, cucumber magnolia, common apple, red mulberry, black tupelo, pine (Austrian, white, Scotch), plane tree (London, American), common pear, pin oak, and Canada hemlock.

Those with generally poor resistance to ice include:

Box elder, silver maple, speckled alder, poplar (white, eastern, southern, Lombardy), aspen (bigtooth, quaking), apricot, cherry (pin, black), common chokecherry, peach, black locust, willow (yellowstem, white, Babylon weeping), Japanese pagoda tree, linden (American, silver), and elm (American, slippery, Siberian).

Waterspout Over Boca Chica

ON SEPTEMBER 26th, a waterspout passed directly over the Airport Station at Boca Chica, causing quite a flurry of excitement at the Navy base. In transmitting a copy of a report prepared by J. M. Langston, one of the observers on duty at the time, R. L. Frost, USWB, Key West, Florida, writes:

"It was apparently weak and about to dissipate at the time as it had already crossed about a mile of the island. For this reason no damage was done. Had it been a fully developed spout, it is likely that considerable damage might have occurred to the blimps and planes parked about the place.

"We had two observers on duty at the time. They stood outside and watched the waterspout approach; then they ran into the office at the last minute. It is the first time I have ever heard of weather observers being chased indoors by a waterspout."

Mr. Langston's report is here reproduced in substance:

At 1613 EST, September 23, 1949, a small waterspout was sighted east-northeast of Boca Chica field about one mile from the station. The waterspout was white in appearance, on the leading edge of a cumulonimbus-calvus cloud. As it drew nearer, movement of the cloud effect within the spout indicated counterclockwise circulation. It did not appear to be reaching the ground, but it was estimated to be from 50 to 75 feet in diameter, becoming somewhat smaller at the lower end. As the spout moved almost directly overhead, this proved to be wrong, for a blimp on the edge of the field was observed to turn on its mooring mast and pieces of trash and an improvised door of about three by five feet were picked up into the air along with small boards. These were lifted from 25 to 50 feet into the air and dropped. As the spout was coming straight towards the station, I left

(Continued on page 141)

FORECASTING THE WEATHER

The Weather Types of North America — 6

ROBERT D. ELLIOTT
AMERICAN INSTITUTE OF AEROLOGICAL RESEARCH

THE PRECEDING ARTICLES were devoted primarily to descriptions of the weather types of North America. It is hoped that these descriptions were sufficiently clear to have aided the reader in recalling similar past weather patterns that he has experienced or to note the weather type of current situations, and in this way to tie the types in with reality.

It is quite beyond the scope of this article to present a set of actual examples in the form of a series of weather maps or to extend the preceding material in any other detailed manner. In this final article of the series there will be outlined briefly methods whereby the weather type information is made use of in forecasting. The amateur who has available daily synoptic charts and the professional will find some items of use to him in what follows. To others, the general information should be of interest. Some of these methods are not only valid for extended period but also for shorter range forecasting.

The first tool used by the weather type forecaster is a set of "ideal" type charts. The schematic diagrams already shown are essentially condensations of ideal charts. The ideal charts show more detail, because there is one for each day of the life of a given type. An example of such a set of charts for type **Bn-b** is shown in the accompanying figure. By comparison of the synoptic weather chart with the set of ideal charts, it is possible as a rule to establish the weather type by the first day of the type. An experienced forecaster can often anticipate the development by one day. This allows two days in the former case, and three days in the latter case, during which the ideal charts can be expected to conform to the observed weather maps. Since there is a high probability that the same type will continue on into Zone 4 (east of the Rockies) from Zone 3 (west of the Rockies) during the ensuing three-day period, the ideal charts are usually good for five or six days in the East. In addition, about two thirds of the time the same type repeats itself at least once, thus extending still further the probable usefulness of the ideal charts.

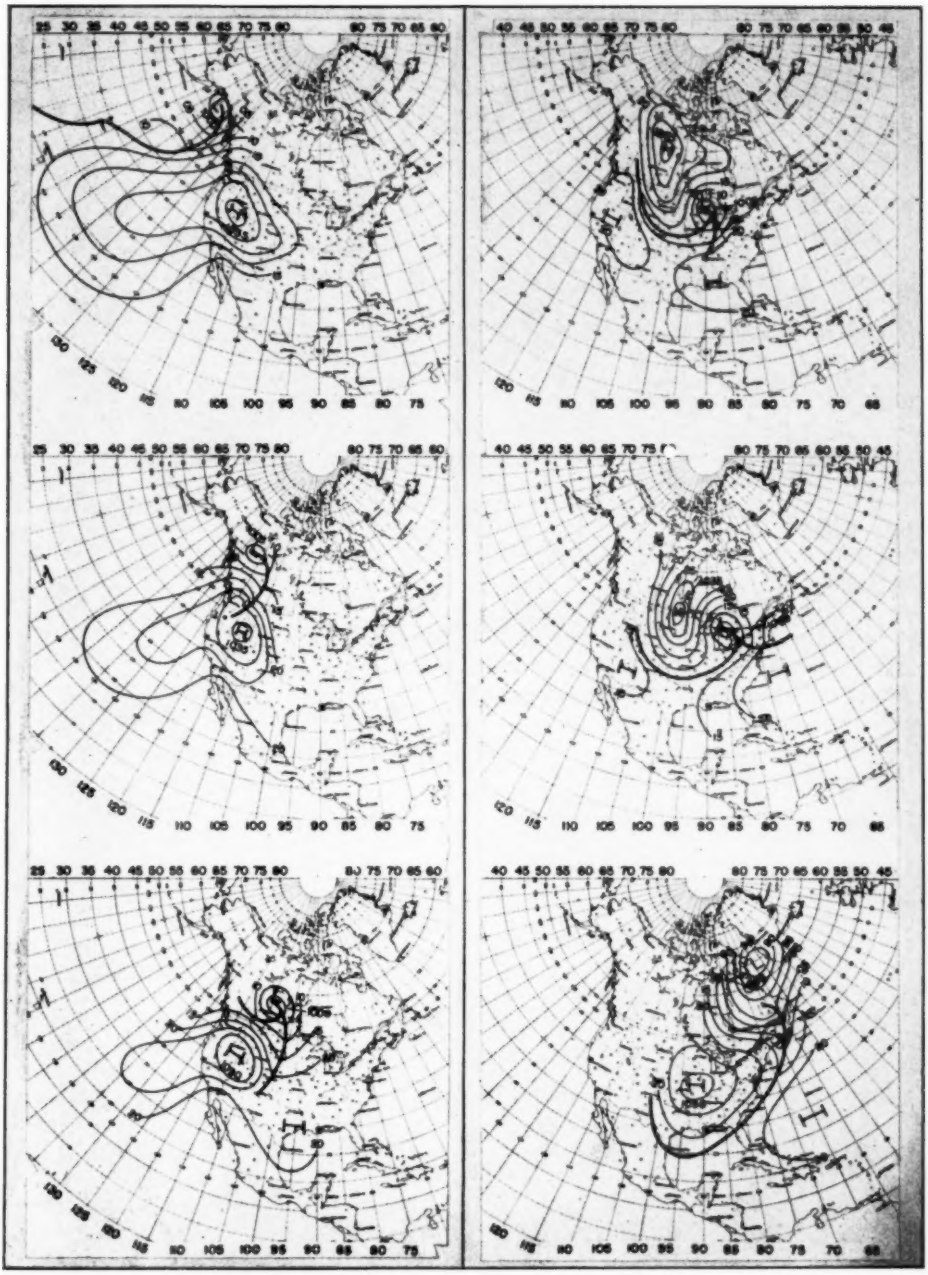
Naturally, a number of cases arise in which the current weather situation fits a given type only moderately well. In these cases the forecaster must use his judgment and experience in modifying the prediction given by the ideal charts in accordance with the current discrepancies between the ideal and observed weather patterns. For example, the storm tracks may be shifted south, or north, or be slanted a little northeast-southwest of normal for the type.

Another way in which such difficult cases can be met is through the use of a weather type analogue. By analogue is meant a past weather situation which has resembled the current situation for several days and which might be expected to continue showing similarity. The weather types have been catalogued for 46 years, and by reference to this catalogue it is possible rapidly to determine the dates of all of the cases of past weather corresponding to the current type. These are usually selected for the month of the year corresponding to that of the current case in order that seasonal effects be avoided. The weather maps for these cases are removed from the archives and studied in detail. In these will be found a number of variations from the ideal pattern, and usually one which shows a similar variation as in the current case. It can then be used as an aid in forecasting in preference to all of the other analogues. Another factor to be considered in this connection is that an analogue matching the current situation over an extended region such as North America and the Pacific will prove to be a better analogue over a longer period of time than one which does not match over an extended region, although the latter may be even a better match at the time in the area of interest.

By the time the forecaster has made the above considerations and is thinking in terms of the weather for many days ahead over an extended region, it becomes necessary in order to avoid confusion that he prepare prognostic charts. These are simply a series of charts just like real weather maps containing isobars and fronts, excepting that they represent the forecaster's prediction. By use of these charts the forecaster and others can in turn predict the actual weather events, such as temperatures and precipitation at specific locations, for various numbers of days ahead.

In addition to using the prognostic chart in predicting the actual weather elements, there are available collections of weather type statistics that can be used in conjunction with the ideal charts to make such predictions. Thus, for example, it is known that on the third day of type **Em** there is a 50-50 chance that the rainfall will exceed half an inch at San Francisco, whereas the chance for half an inch on this day in Seattle is about half as much.

Because it is often possible to make a reliable forecast of the mean temperature or precipita-



Ideal charts for North American weather type *Bn-b*. The charts cover the three days of phases 1, 2, and 3 in Zone 3 (left side, top to bottom) and the succeeding three days in Zone 4. Zone 3 extends from 135° west to 90° west; Zone 4 extends from 90° west to 45° west.

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tion for the ensuing several days or week, whereas it is much more difficult to give the day-by-day weather departures due to inherent irregularities in the rate of movement of storms, most extended range forecasters prefer to emphasize the predicted mean conditions for the forthcoming period. Type statistics have also been assembled for mean periods, and these have proven even more useful than the daily statistics.

The difficulty in extended period forecasting lies in establishing what the next weather type and, in some cases, what the next two types are to be. Naturally, if these could be predicted perfectly the forecast of actual weather events for beyond the life of the current type could be made with nearly as great an accuracy as that for the life of the current type. Various methods are used for accomplishing this. One involves the study of long-period and major changes in the Northern Hemisphere circulation patterns. It is beyond our scope here to discuss this method, but it may be said in passing that while considerations of this type are of only limited value at present, they certainly hold promise for the future. Another method involves the use of statistics in predicting coming types. It has been found that the coming type or types depend to some extent upon the past several types in the zone in question and in neighboring zones, and prediction schemes can be developed which forecast the coming types on this basis.

WEATHER WISDOM AND THE TELEPHONE

(Continued from page 133)

ly every spot in the United States. The map on page 133 summarizes the data taken over a period of 25 years.

The National Electrical Safety Code, sponsored by the National Bureau of Standards and prepared by the American Standards Association, divides the United States into three storm loading areas: *heavy*, *medium*, and *light*, as shown on page 132. Among other things, this code specifies the ice and wind loads which overhead lines must withstand in each of these areas. In preparing the code, use was made of storm data collected by the U. S. Weather Bureau and various utilities.

Through careful study of the storm history of every section of the country, and through research on line design, Bell System experts are building low-cost lines of ever-increasing dependability. They rely heavily upon those who through patient study and careful observation are learning more and more about the weather.

CLIMATE CONTROL PROJECT

House Beautiful. October, 1949, to July, 1951.

A LARGE-SCALE program in applied meteorology has recently been launched by **House Beautiful,** to which we would like to call our readers' attention. For the next 22 months this widely read magazine in the home building and house furnishing field will devote many columns to its "Climate Control Project."

In the words of the editor, the project proposes "to show Americans how they may work toward controlling their total indoor environment and partially controlling their outdoor environment. This includes all things that touch on our five senses — which means light and glare control (day and night), sound control, sun control, wind control (indoors and outdoors), humidity control, sanitation control, temperature control, disaster control, insect control, snow control, free thaw control, etc. In short, the Climate Control Project deals with precisely fitting the design characteristics and specifications of a house to its climate in order to reduce the stresses and strains which that climate puts on Man and Materials."

The project was launched in the October, 1949, issue of **House Beautiful** with several general articles and a specific discussion of the microclimate of Columbus, Ohio. In subsequent issues the following areas will be treated: Suburban New York (November, 1949), Miami (January, 1950), Arizona (March, 1950), St. Louis (May, 1950), New Orleans (June, 1950), Chicago (July, 1950), Suburban New York (October, 1950), Washington, D. C. (November, 1950), Boston (January, 1951), St. Paul (February, 1951), Pittsburgh (March, 1951), Charleston, S. C. (April, 1951), Portland, Ore. (May, 1951), Albany (June, 1951), and Denver (July, 1951).

Dr. Paul A. Siple, the consulting climatologist to the project, is preparing an environmental analysis for each of these localities. Digests will be published in **House Beautiful,** and the full reports will appear bimonthly in **The Bulletin of the American Institute of Architects.** Reprints may be purchased by AWA members at 50 cents each from the Climate Control Project Administrator, House Beautiful, 572 Madison Avenue, New York 22, N. Y. Readers of **Weatherwise** will be especially interested in Dr. Siple's extensive charts, which present the basic climatological factors in new and intriguing form. These are: Thermal Analysis, Solar Analysis, Precipitation Analysis, Wind Analysis, and Humidity Analysis. Many salient facts about the local microclimatology of the area are brought out by these revealing charts. Amateur weathermen may use these as a guide in compiling their own studies of local microclimates.

Though much has been previously compiled on the subject of climatic environment in building, the present project approaches the proposition not just to establish facts, but to make sense out of the mass of Weather Bureau records. The use of monthly and annual means or averages has been largely discarded, and daily and even hourly statistics have been combed to bring out the extremes and variations of local climate.

Housing, of course, has been and will continue to be one of the major problems facing our country, so during the coming months we shall carry information on the subject of microclimatology and the house builder that will perhaps make for a more weatherwise America.

D. M. L.

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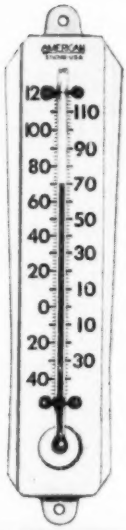

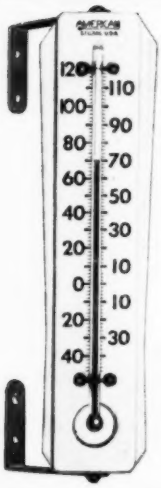

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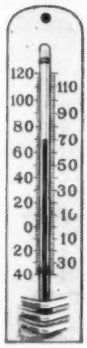

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November Storms

NINETEEN INCHES of snow in 28 hours at Buffalo, New York, on November 15-16, set a record for that city. The storm was of the open-fetch type, in that southwest winds blew the length of Lake Erie and the unstable air deposited its moisture on reaching shore. The area of heavy snow was only eight miles wide. The previous record November snowfall at Buffalo was 14.8 inches in 1920. Later this November Cleveland had a similar storm to start an early winter.

The eleventh month of 1949 will go down in history as producing the very destructive storm of November 26-27 in the Pacific Northwest, causing a reported 14 deaths and millions of dollars of property damage. Wind velocities of 105 miles per hour were reported from Cut Bank, Montana, and of 96 miles per hour from Sheridan, Wyoming. Torrential rains caused heavy flooding of the Skagit River in northwestern Washington, and the Red Cross was alerted for a possible major disaster, according to an Associated Press account. The Skagit River at Mount Vernon was expected to overflow new dikes erected there recently for flood levels of 26 feet.

Oregon, Idaho, and British Columbia, in addition to Washington State, felt the brunt of the storm. Weather Bureau warnings, made since the development of the storm 2,600 miles out in the Pacific four days earlier, prevented damage to shipping, but six men died at sea near Trial Island, 10 miles northeast of Victoria, when a tugboat capsized. The 826-foot broadcasting tower of radio station KHQ was broken in half at Spokane, and at Colville, Washington, a lumber storage shed 250 feet long was collapsed by the wind.

The closing days of November brought the eastern states a slippery snowstorm, and in the outlying sections of Miami, Florida, there were unofficial thermometer readings of only 30°. Frost hit the Lake Okeechobee truck farming region, with damage to between 75 and 90 per cent of the bean crop on the south side of the lake. In the Atlantic Ocean, storms delayed such large vessels as the French liner **De Grasse**, which docked on November 27th a day and a half late.

In New England, traffic at the close of the Thanksgiving Day weekend was seriously affected, and many persons lost their lives in automobile accidents on the slippery highways. The skiing season had already begun at many northern New England high spots, including Stowe, Mad River Glen, Middlebury and Pico in Vermont, and Cannon Mountain and Pinkham Notch in New Hampshire.

WATERSPOUT OVER BOCA CHICA

(Continued from page 135)

the walkway and ran into the station and observed it from the doorway of the office. It passed over the station and crossed the edge of the field, dissipating about half a mile away at 1624 EST.

During the time the spout was near the station a slight swishing sound was heard. Just before the spout reached overhead, the wind was from the west at about one to two miles per hour. As the spout passed, the wind shifted to the east and picked up in force to about 20 knots from whence it had been blowing previously about five to six knots. Light rain was falling throughout the time the waterspout was formed, and when it was near the station rain would pelt down in spurts. When the spout was directly overhead, it appeared as a white puff against the rest of the cloud, and the base of the circulation was noted to be approximately 200 yards to the right and rear of its entrance into the cloud base. The clouds were moving from the east-northeast at the time and were estimated to be between 3,000 and 3,500 feet high.

The barograph reading was 29.875 just before the waterspout was observed, and as it passed over the trace on the barograph dropped to 29.860. It then rose to 29.890, and after the passage of the spout returned to its normal trace of 29.875. No temperature or humidity changes could be noted as instruments were not available.

At 1654 EST another spout was observed to start forming east-northeast of the field but it soon dissipated.

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CONDUCTED BY CHARLES A. LAIRD

How to Construct a Rain and Snow Shield

WIND EDDIES around a rain or snow gage will result in inaccurate readings; usually they cause the gage to show less precipitation than has actually fallen. This deviation is particularly noticeable during snowstorms. To help correct it, various types of shields have been tried to straighten out the flow of air.

The ideal shield will maintain a horizontal flow of air across the mouth of the gage, exactly as if no obstruction to normal air flow were there.

The shield described here is the correct size for use with the gage discussed in this column in the April, 1948, issue of **Weatherwise.** As can be seen in Fig. 1, it consists of a truncated cone surrounding the gage and mounted so that its top edge is about one inch above the top of the gage. Medium weight galvanized sheet metal may be used.

Fig. 2 shows the manner of marking off the metal for cutting. Use a protractor for finding the angle, and a looped piece of string for a compass. Allow about an inch of overlap at one end for soldering the ends together to form the cone. Or, if you don't care to solder it, use small bolts.

The shield may be mounted on three 2" x 2" stakes spaced at equal distances around the gage. Short lengths of strap metal, bent to the proper angle and bolted to the shield, are used to anchor it to the stakes. This construction is shown in Fig. 1. A single wood screw, passing through the upper part of each angle strap and into the top of the stake, will hold the shield in place.

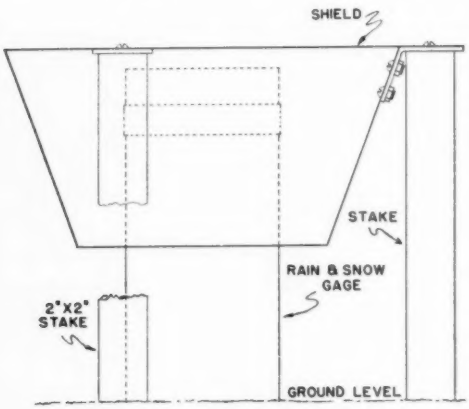


Fig. 1. The mounting of the conical shield. One of the stakes supporting the gage is shown cutaway so that the full outline of the shield may be seen.

Fig. 2. The manner of cutting the sheet metal to form the shield for the rain and snow gage.

The gage itself is held by three or four short stakes, spaced equally around it. One of these is shown in Fig. 1. If you remove the funnel and measuring tube, and use the outer part of the gage alone for measuring snow, put a block of wood under it to bring its top to the proper level.

If your rain gage is of another size, dimensions of the shield must be altered accordingly. The bottom end of the cone must not be so small that snow, falling in the shield, cannot pass through. If you live in an area where heavy snows are common, the gage and shield should be mounted high enough so that drifts do not cover them.

The type of shield used by the Weather Bureau is called the Alter shield. It is similar in construction to the one described here, except that the cone is constructed of strips rather than solid metal. The December, 1948, **Weatherwise** has some excellent photographs of Alter shields mounted on large, capacity-type snow gages (page 132).

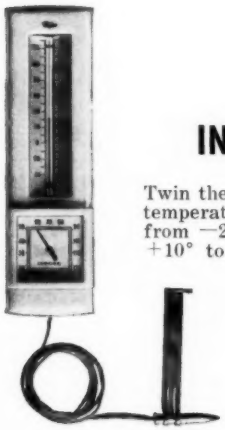
WEATHER GENERAL

A noted United States weatherman, Joseph J. George, of Atlanta, Georgia, was promoted to brigadier general in the United States Air Force Reserve on September 16, 1949. General George, superintendent of meteorology for Eastern Air Lines, has been active in reserve affairs since his separation from the Air Force at the end of World War II, and has been given a mobilization assignment in the event of war as deputy chief, Air Weather Service, Andrews Air Force Base, Maryland.

FOLLOW THE WEATHER AT HOME!

QUALITY BAROMETER

U. S. Weather Bureau type — graduated in both inches and millibars, reading to 0.02 inches and to one millibar. Open face silver dial five inches in diameter. Contains high-grade movement that is compensated for temperature changes. Adjustable pointer for comparative readings. Weight 1¾ lbs. For use between sea level and 3,000 ft. (Available for higher altitudes at five dollars additional.)
$30.00



CONVENIENT INDOOR - OUTDOOR THERMOMETER

Twin thermometers indicate outdoor air temperature and indoor room temperature. Red reading tube on scale shows outdoor temperature from −20° to +130° F. Red pointer shows room temperature from +10° to 130° F. on two-inch diameter dial. Instruments built into attractive plastic case, either walnut or ivory finish. Five-foot capillary tube permits installation at convenient location. Bracket and screws provided for proper exposure of capillary bulb. Size 9½ inches long by 2¾ inches wide.
$7.50

LARGE WINDOW THERMOMETER

Large-diameter tube has magnification for easy reading. Hand-blown bulb assures accuracy. Pleasing gray and ivory vitreous enameled scale with bold black numerals fired-in for permanence. Scale is 10" in length and reads from −40° to +120° F. Stainless steel mounting bracket with screws.
$3.50

"Everything for the study and practice of meteorology"

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